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AUTHOR Berkheimer, Glenn D.; Caldwell, John
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ABSTRACT

This unit is intended to introduce the ideas of interaction and systems and their relationship to energy. The concept of energy is developed to include energy sources, energy receivers, energy transfer, energy chains, and efficiency. The unit is intended for use in two class periods and relates to concepts of science and social science. Numerous charts, tables, and illustrations are provided. (RE)

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IT ISN'T WHAT YOU'VE GOT, BUT HOW YOU USE IT or ENERGY AND EFFICIENCY

TEACHER'S GUIDE

ED190346

BY
GLENN D. BERKHEIMER and JOHN CALDWELL

MICHIGAN STATE UNIVERSITY
SCIENCE AND MATHEMATICS TEACHING CENTER
E-37 MCDONEL HALL
EAST LANSING, MICHIGAN 48824
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U.S. DEPARTMENT OF HEALTH
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SE 030 977

IT ISN'T WHAT YOU'VE GOT, BUT HOW YOU USE IT or ENERGY AND EFFICIENCY

Unit Title: Net Energy

Module Title: It Isn't What You've Got, But How You Use It or Energy and Efficiency

Description of the Module: Many of the basic ideas necessary to understand other modules are presented in this module. The ideas of interaction and system, frequently used in both science and social studies, are first introduced in this module. These ideas are then used to introduce the concept of energy. The concept of energy is developed to include energy source, energy receiver, energy transfer, energy chain, and efficiency.

Unit Objectives Met: 1a, 1d, 2a, 2c, 4a

Materials Needed: Paper, pencil, larger rubber band, wastebasket, a nerf ball, and Student Pages

Module Type: Required

Context: Science and Social Science

Time Required: Two class periods

Mode: Demonstration, discussion, reading, and writing

Sample Evaluation Items

The Youth Energy Project is funded by the Michigan Department of Commerce and the Michigan Energy Extension Service on a pilot basis. Michigan State University's Cooperative Extension Service (4-H - Youth Programs) and the Science and Mathematics Teaching Center are the project contractors. This material was prepared with the support of the U.S. Department of Energy (DOE) Grant No. EC-77-6-01-5092.

SAMPLE EVALUATION ITEMS

1. What is efficiency?

Answer: A comparison of energy that we receive from a system to the energy that was put into the system.

2. What factors affect the efficiency of energy systems?

Answer: The largest factor is energy transformtions. Others may include heat loss or friction.

3. What is the most (least?) efficient method of generating electricity? How could the efficiency of the system be improved?

Answer: Most efficient - Hydro electric
Least efficient - Uranium or Nuclear

The system could be improved by a) reducing the number of energy transformations, b) reducing friction and c) improving efficiency of energy transformation.

4. Suppose you hold an ice cube in your hand for two minutes. What are the energy sources? energy receivers?

Answer: Energy sources - hand, air

Energy receivers - ice cube, water

5. Using arrows and words, draw a diagram to illustrate the above ice melting system.

Answer: Hand ⟶ ice or Air ⟶ ice

6. A bowler uses his muscles to send a bowling ball down the alley and the ball strikes the bowling pins. Using arrows and words, draw a diagram to represent this energy chain.

Answer: Bowlers muscles ⟶ bowling ball ⟶ bowling pins

7. A baseball player hits a ball to left field, a player in the left field catches the ball and quickly throws it to the third baseman who tags the batter out at third base. Draw a diagram to represent this energy chain that directly involves the ball.

Answer: baseball player's muscles ⟶ bat ⟶ ball ⟶ left fielder's glove ⟶ left fielder's muscles ⟶ ball ⟶ third baseman's glove ⟶ batter

Purpose

This activity is to introduce the major concepts necessary for students to understand energy, energy transfer, and efficiency. The concepts that are introduced in this module are: interaction, system, energy, energy source, energy receiver, energy chain energy transfer, energy loss during energy transfer, and efficiency.

Advanced Preparation

Collect a large rubber band, several sheets of paper, and a nerf ball. Duplicate the student pages so that each student has each page.

Background Information

Our everyday environment has abundant examples of energy related concepts. By considering the relationship of energy and motion, one can think of many examples. Consider a bowler who rolls a bowling ball down the alley and strikes bowling pins. By analyzing this simple situation you can see the relationship of many of the concepts in this module. In the interaction of the bowler's muscles giving energy to the bowling ball, the bowler's muscles are the energy source, the ball is the energy receiver. Energy is, therefore, transferred from the bowler's muscles to the ball. Energy is required to move objects. As the bowling ball strikes the pins, energy is transferred from the ball to the pins. During this interaction the bowling ball is the energy source and the pins are the energy receivers. In this example, there were two energy transfers linked together by the sequence of events: the bowler's muscles transferred energy to the bowling ball and the bowling ball transferred energy to the pins. A series of two or more energy transfers is called an energy chain. In order to help the students understand the sequence of energy transfers, we

represent energy chains by diagrams consisting of key words and arrows. For example, to represent the transfers described by the bowler we would write:

Energy Transfer Energy Transfer
Bowler's muscle --------> bowling ball --------> bowling pins

Efficiency is another important energy concept. Generally, we consider an interaction efficient if it takes place quickly and effectively. For example. if a person preparing a meal performs that task with a minimum amount of unnecessary movement, and the parts of the meal are ready at the same time, then we consider that person to be an efficient cook.

In physics, efficiency is used with reference to machines and work.

In this module, the students will consider the efficiency of energy systems. The definition of efficiency used is a comparison of energy that we receive from a system to the energy that was put into the system. The system will start with the energy in the ground, its transfer and transformations until it is received in a usable form. Therefore, we go beyond the physical approach of considering only the machine and use the non-mathematical approach used by laymen.

The objective is for students to be able to compare relative efficiencies of electricity production. The students will not consider the efficiencies of the systems used to make the objects within the energy production system.

Introduce the lesson by telling the students that they will learn a series of energy concepts that are prerequisite to other modules in the net energy unit. Pick up a half piece of paper and crumble it in your hands. Ask the students to identify the changes in the paper. Explain that when one object affects another such as your hands affected the paper, the objects are said to interact. The process by which one object moves or changes another object is called interaction.

Stretch a rubber band between your two thumbs. Moving your hands back and forth, challenge the students to give evidence of interaction and name the objects that are interacting. Explain that a group of objects that can interact, are interacting or have interacted is called a system. Explain further that we list the objects in a system as a convenient way of identifying those objects that are involved in the interaction.

As you distribute Student Page, Interaction and System, challenge the students to apply the ideas that they have just learned in answering the questions on this page. After the students have answered the questions on the page, discuss the concepts of interaction and system thoroughly and re-teach if necessary.

INTERACTION AND SYSTEM

In this module you will learn many ideas and terms used frequently in the study of energy. Mastery of these basic ideas will aid you in learning and discussing many energy related issues.

When one object moves or changes another object, they interact. Interaction is the process by which one object moves or changes another object. What evidence of interaction do you see in the picture? What interactions can you infer from the evidence? A group of objects that can interact, are interacting, or have interacted is called a system.

Football player kicking
a football--Ball in air

1. Describe specific interactions that occur in several sports events.

   Answers will vary.

2. Name the objects in each sports event system.

   Answers will vary.

3. What are some of the objects that make up your circulatory system? respiratory system?

   Circulatory - heart, veins, arteries, blood. Respiratory - lungs, air, diaphram, nose, trachea.

4. Name the objects in each of the systems listed:

   wood chopping system - *wood, ax, person*

   school system - *schools, teachers, students, administrators*

   bicycle drive system - *leg, peddle, sprocket wheel, chain, back wheel*

   hair drying system - *motor, air, hot wires, water on hair*

ENERGY AND ENERGY TRANSFER

Energy is a system's ability to bring about interaction in other systems or within the same system. Objects in a system need energy to move or interact. An object in a system that supplies energy is called an energy source. An object in a system that receives the energy is called an energy receiver.

**The Student Page, Energy and Energy Transfer, is designed to introduce the concepts of energy, energy source, energy receiver, energy transfer, and energy chain. Start the activity by tossing a nerf ball to a student. Emphasize that energy is necessary to move objects or change their direction. Energy, therefore, is necessary to bring about interaction in a system. Toss the nerf ball to another student. Emphasize that the object in a system that supplies energy is called the energy source. The object in a system that receives the energy is called the energy receiver. Now place the ball on the floor and kick it toward the waste can. Emphasize that the traveling of energy through a system from the energy source to an energy receiver is called energy transfer. Stress that your foot transferred energy to the ball and the ball transferred energy to the wastebasket. Also, emphasize that a series of two or more energy transfers is called an energy chain. Distribute Student Page, Energy and Energy Transfer, and discuss the diagrams used to represent energy transfer completely. Challenge the students to study the page and answer the questions completely. After the students have completed this task, discuss the activity making sure that they understand the basic energy concepts.*

Identify the energy source and energy receiver in these events:

A person kicks a football. *Energy source - the person. Energy receiver - football.*

A person hits a tennis ball with a tennis racket.
Energy source - person and tennis racket. Energy receiver - ball

A hammer drives a nail.
Energy source - person and hammer. Energy receiver - nail

The traveling of energy through a system from an energy source to an energy receiver is called <u>energy transfer</u>.

For example, a foot kicking a football can be represented by a diagram.

<u>Energy Transfer</u>

foot ----------> football

energy source energy receiver

Draw similar diagrams for:

a hammer hitting a nail *hammer ⟶ nail*

a cue ball hitting the eight ball. *cue ball ⟶ eight ball*

toaster making toast *toaster ⟶ toast*

a hockey player passing a puck *hockey player ⟶ puck*

Two or more energy transfers within a system is called an <u>energy chain</u>.

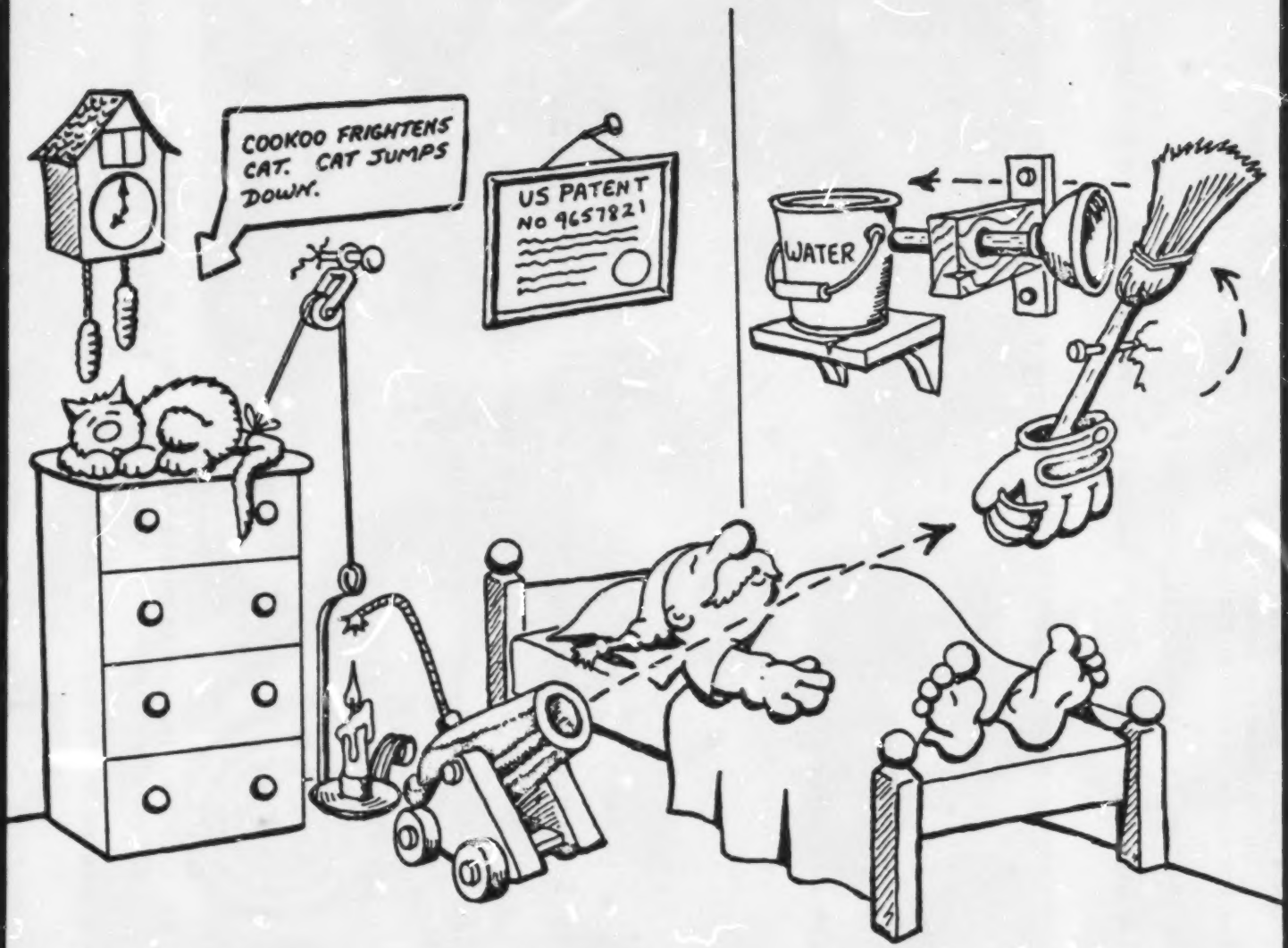
Words and arrows can also be used to illustrate energy chains.

bow ⟶ bow string ⟶ arrow ⟶ target.

Use similar diagrams to illustrate

1. A bowler making a strike.
   Bowlers muscles ⟶ bowling ball ⟶ bowling pins
2. Hockey players passing a puck several times and then making a goal.
   Hockey player 1 ⟶ puck ⟶ hockey player 2 ⟶ puck
3. Baseball player hitting a ball and another player catching a fly.
   Baseball player ⟶ bat ⟶ ball ⟶ baseball player 2
4. Bicyclist leg muscle moving the back wheel of a bicycle.
   leg muscles ⟶ pedal ⟶ large sprocket ⟶ chain ⟶ small sprocket ⟶ wheel

Make a diagram to represent the energy chain in The Wake Up System.

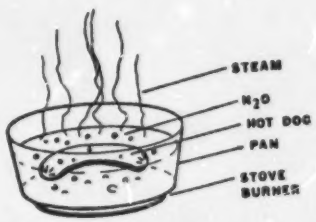

COOKOO FRIGHTENS CAT. CAT JUMPS DOWN.
US PATENT NO 9657821
WATER

*The Student Pages, System Efficiency, can be used with individual or groups of students. If the individual approach is used, it is recommended that once a number of students have completed the module, a group discussion be conducted. Most of the information needed is found on the student pages.

*Begin the lesson by having the students view a diagram of a burner, pan of water, and a hot dog. Tell them that it is called our Hot Dog Cooking System (HDCS). What follows are possible answers to the questions. The exactness of student response is not as important as the ideas.

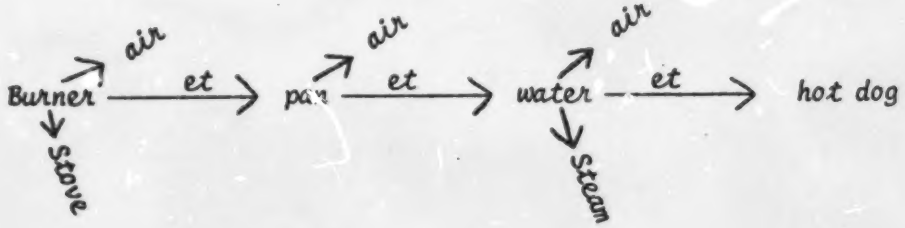
SYSTEM EFFICIENCY

In this activity you will use the ideas of energy chain, energy transfer, and system learned in previous activities. Below is a diagram of a hot dog cooking system (HDCS). As the name implies the system is used to cook a hot dog.



1. Diagram the HDCS energy chain, labeling the energy sources, energy receivers, and with arrows indicate where energy is transferred.

   Answer: The students diagram may only suggest something like burner → water → hot dog. Ask the students to be more explicit. The students diagram should be similar to the following"



et = energy transfer

2. Does all the energy from the burner go to the hot dog? If not, where does it go?

   Answer: *NO, some of the energy goes to the air from the burner pan to air*
   water to air via steam.

3. How much of the energy from the burner goes into the hot dog? If we compare the amount of energy that is transferred in the system to the hot dog to the amount of energy the energy source puts into the system, then we have an indication of the efficiency of the system.

   Answer: *The determination of how much energy goes to the hot dog does not have an exact answer. The student should be able to suggest a quantity. Basically, less than 1/3 is a reasonable estimate.*

4. How efficient is our HDCS system? Why?

   Answer: *Repeat the definition for the students, and basically, the syster is inefficient. Why? Because there is a lot of energy loss (refer back to the amount the hot dog received; if they say 1/3 then 2/3 is lost).*

5. What if we put a cover on the pan in the system. What would that do to the efficiency of our system? Why? If we use more water, how would this change the efficiency of the system? Why?

   Answer: *Placing a cover on the pan should redirect some of the heat being lost through the steam back into the water and increase the efficiency of our system. Now the definition of efficiency is refined. The student will look at some tables representing the efficiency of various energy systems. Adding more water to the pan would make the system less efficient because there is more water to heat.*

Efficiency is defined as the comparison of how much energy is put into the system and the amount of energy received so that we can do something. In the above system, the energy received by the hot dog cooked it so we could eat it.

Now, let us look at the efficiency of an energy system for an automobile. Before we look at the diagram,consider the next two questions.

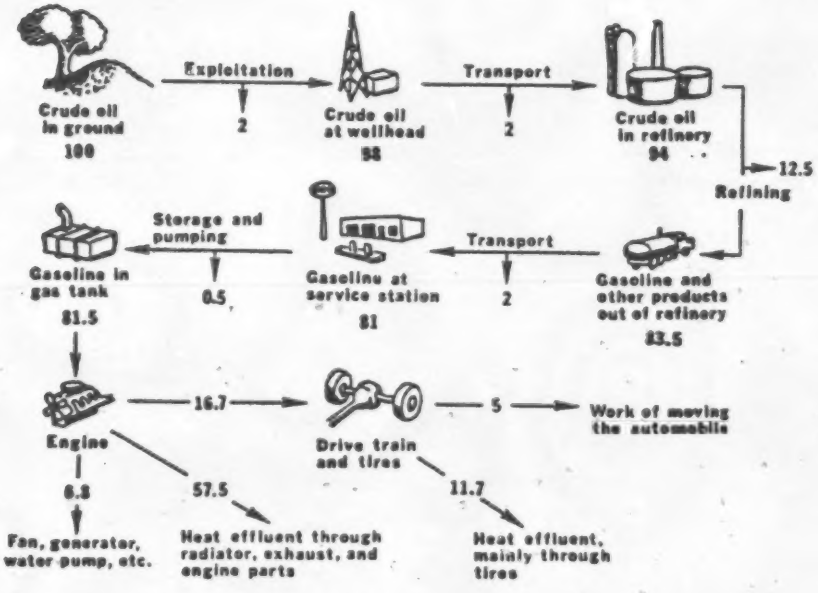
6. Where does the energy for an automobile come from?

Answer: The students may suggest the energy comes from the sun. While true, the sun is not included in our energy system for the auto. We begin our system with oil in the ground.

7. How efficient do you think an automobile is?

Answer: The automobile is very low in efficiency. At this point, however, the exactness of student response is not crucial. The point of the question is to have students begin thinking about the automobile with respect to efficiency.

Energy-system of the American automobile



The table below summarizes the information in the diagram. Within the table we have the efficiencies of each step of the process of transferring energy from the ground to the automobile in motion. Also listed, is how much efficiency is left in the system after each process. For example, in the process of getting the oil out of the ground to the well head we have reduced the total efficiency of the system to 96%. The efficiency of refining the oil to make gasoline is 87%. After that is done, we have 83.5% of the original efficiency left.

Table The Energy-System Efficiency of the Automobile

Step	Step Efficiency	Cumulative Efficiency
Production	96%	96%
Refining of crude oil	87	83.5
Transportation of gasoline	97	81
Thermal efficiency of engine	29	23.5
Mechanical efficiency of engine	71	16.7
Rolling efficiency	30	5

8. What is the resultant efficiency of our energy system?

Answer: After viewing the data presented in the diagram and the table, the students should answer, "the resultant efficiency is 5%."

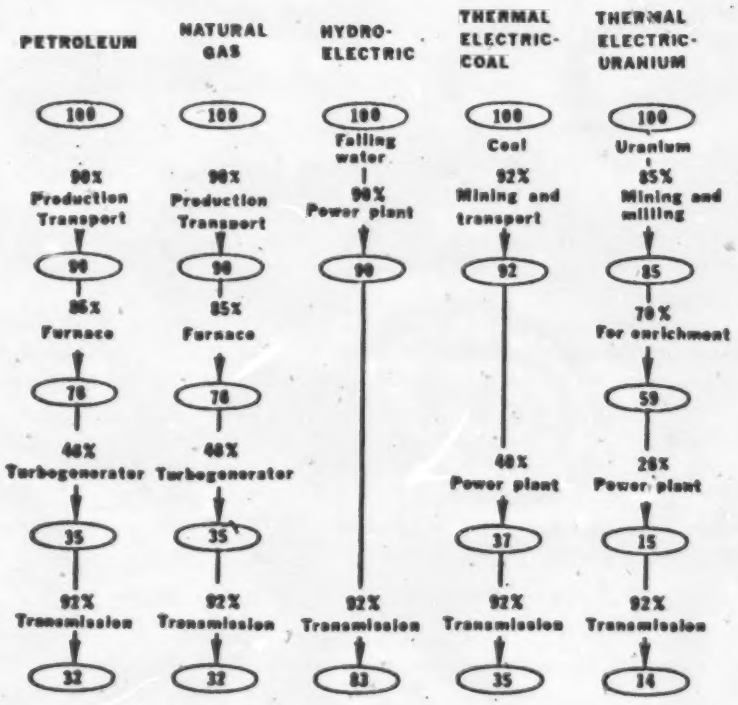
9. Which step has the lowest efficiency? Why? In what ways could the efficiency of the automobile be improved?

Answer: The steps having the lowest efficiency are thermal efficiency and rolling efficiency. The reason basically lies in the transformation of energy. Any time energy is transformed, an enormous amount of energy is lost. Possible ways to improve automobile efficiency may include: Rolling efficiency can be improved by increasing the air pressure in the tires, reducing the weight of the automobiles. The student suggestions need not be technical. Acceptable answers will vary.

*In the diagram of electricity production, efficiencies, the questions asked are similar to those asked about the automobile.

Below is a diagram for systems that produce electricity and a table summarizing the information on the diagram.

Efficiencies	
Petroleum	35%
Natural Gas	32%
Hydro-electric	83%
Thermal electric--coal	35%
Thermal electric--uranium	14%



10. Which of the above is most efficient?

Answer: (Teacher - Read from Chart)

11. Which of the above is least efficient?

Answer: (Teacher - Read from Chart)

12. Which of the above does your electric plant use? Why?

Answer: This answer depends on your area. The reason the system is used is probably based on the economics of the system and the availability of the source. For example, people in Texas will not use water power; petroleum is more available and cheaper. Whereas, people in Buffalo, New York would use water power because of the proximity to Niagara Falls.

13. If you do not use the most efficient energy source? Why?

Answer: If the students are not near a waterfall they may not use hydroelectric. Point out that the source is not available and continue with the lesson.

14. Why are some of these values so low?

Answer: The values are low due to transformation.

15. How might we improve efficiencies?

Answer: Answers will vary. Accept all reasonable answers.

*Data obtained from Man, Energy, and Society. Cook, Earl, W. H. Freeman & Co., San Francisco, 1976.

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Football player kicking a football--Ball in air

1. Describe specific interactions that occur in several sports events.
2. Name the objects in each sports event system.
3. What are some of the objects that make up your circulatory system? respiratory system?
4. Name the objects in each of the systems listed:

   wood chopping system

   school system

   bicycle drive system

   hair drying system

ENERGY AND ENERGY TRANSFER

Energy is a system's ability to bring about interaction in other systems or within the same system. Objects in a system need energy to move or interact. An object in a system that supplies energy is called an energy source. An object in a system that receives the energy is called an energy receiver.

Identify the energy source and energy receiver in these events:

A person kicks a football.

A person hits a tennis ball with a tennis racket.

A hammer drives a nail.

The traveling of energy through a system from an energy source to an energy receiver is called energy transfer.

For example, a foot kicking a football can be represented by a diagram.

Energy Transfer

foot ----------> football

energy source energy receiver

Draw similar diagrams for:

a hammer hitting a nail

a cue ball hitting the eight ball.

toaster making toast

a hockey player passing a puck

Two or more energy transfers within a system is called an energy chain. Words and arrows can also be used to illustrate energy chains.

bow → bow string → arrow → target.

Use similar diagrams to illustrate

1. A bowler making a strike.
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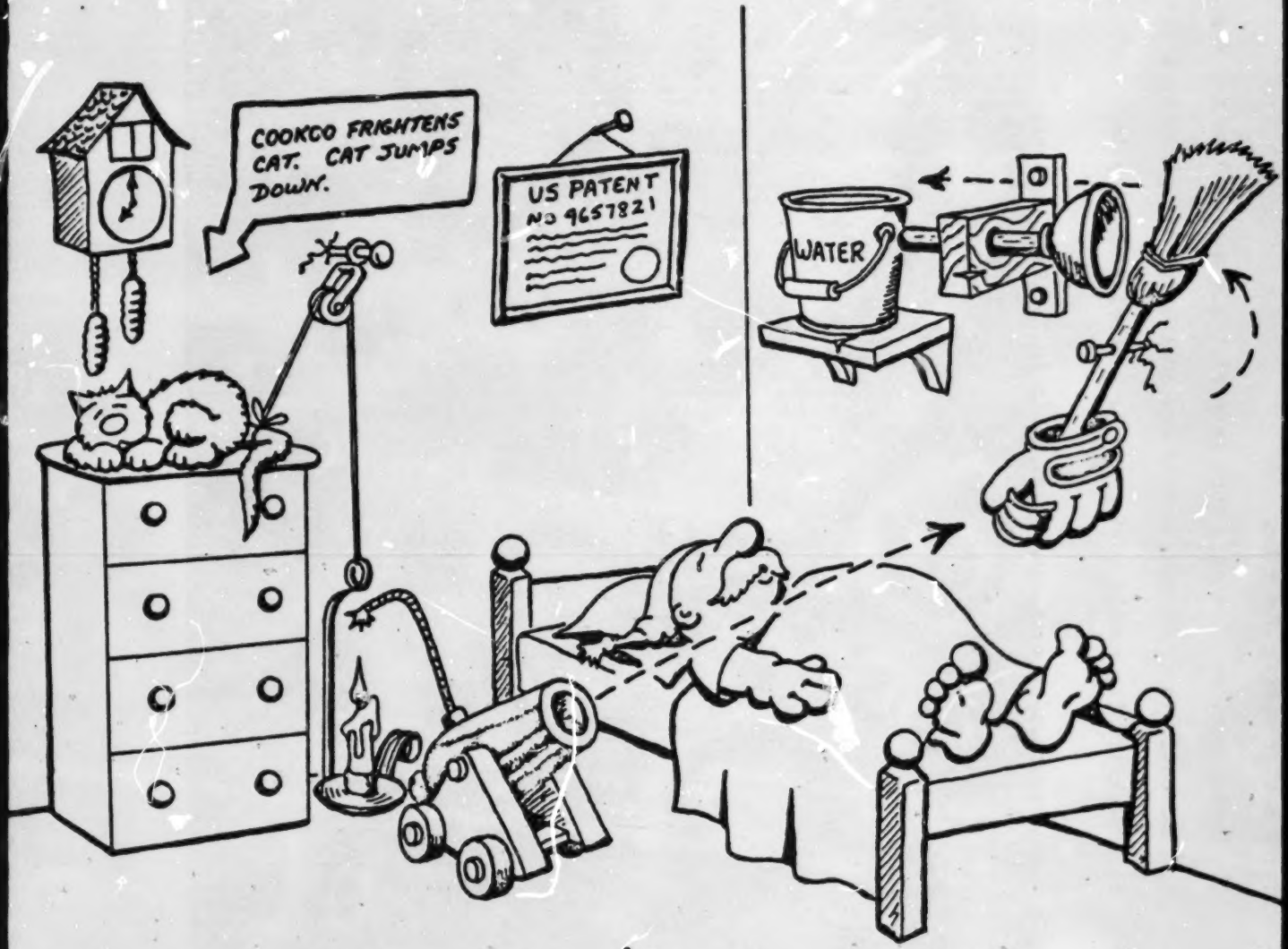
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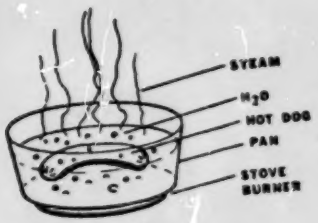

1. Diagram the energy chain in the HDCS and label the energy sources and receivers. With arrows indicate the parts in the energy chain where energy is transferred.
2. Does all the energy from the burner go to the hot dog? If not, where does it go?
3. How much of the energy from the burner goes into the hot dog?

If we compare the amount of energy that is transferred in the system to the hot dog to the amount of energy the energy source puts into the system, then we have an indication of the efficiency of the system.

4. How efficient is our HDCS system? Why?
5. What if we put a cover on the pan in the system. What would that do to the efficiency of our system? Why? If we use more water, how would this change the efficiency of the system? Why?

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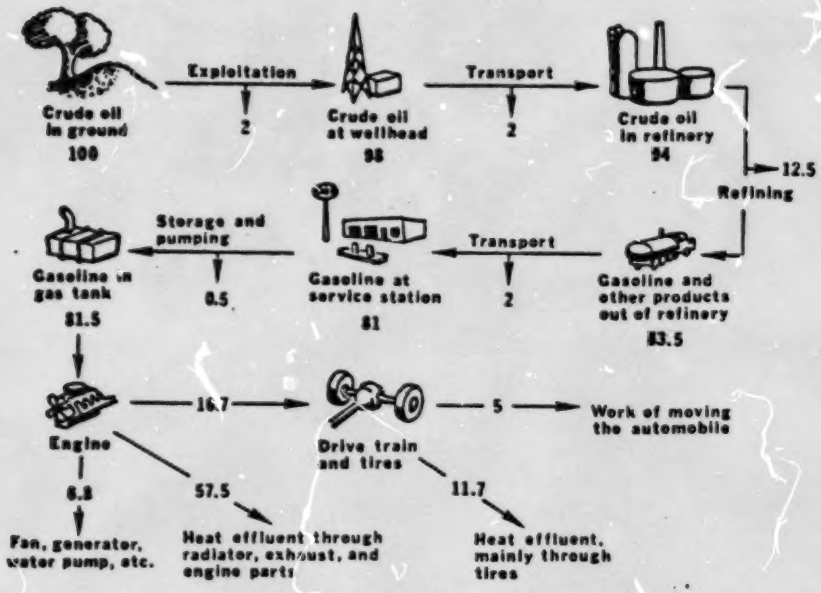
7. How efficient do you think an automobile is?

Energy-system of the American automobile



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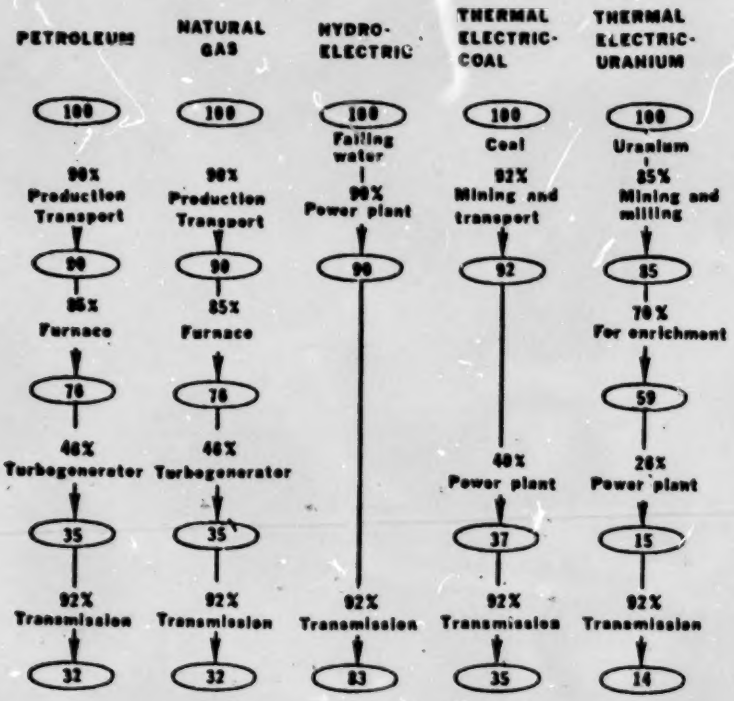

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Hydro-electric	83%
Thermal electric-coal	35%
Thermal electric-uranium	14%

10. Which of the above is most efficient?

11. Which of the above is least efficient?

12. Which of the above does your electric plant use? Why?

13. If you do not use the most efficient, why?

14. Why are some of these values so low?

15. How might we improve efficiencies?